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Modelling Sustainable Options the importance of habit and perceptions

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Background

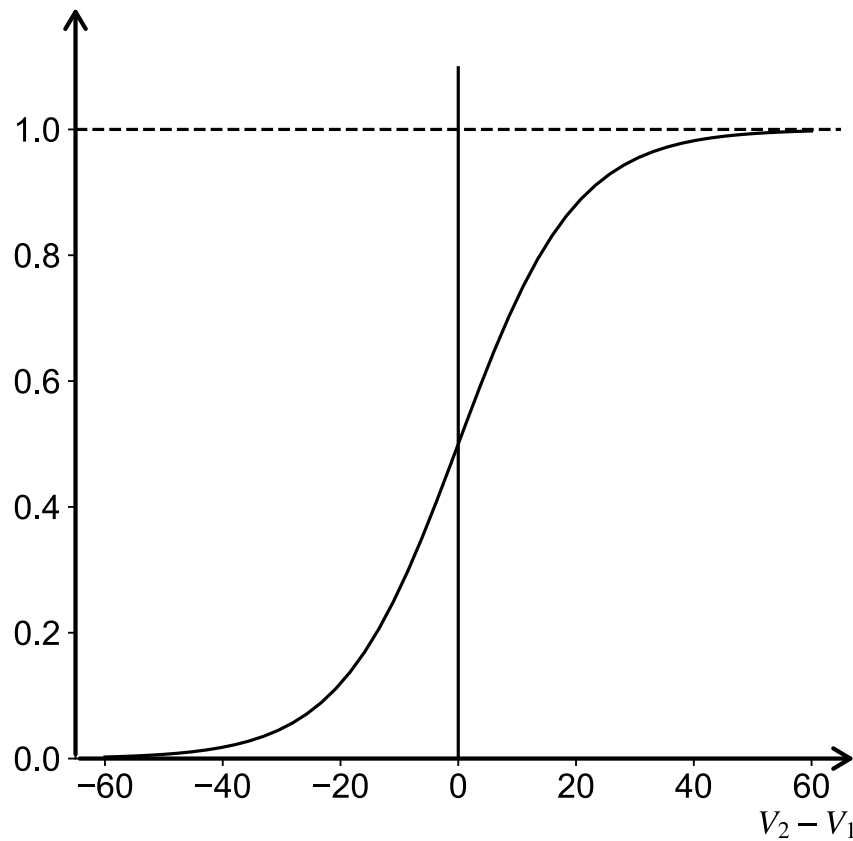
Habit, or the inertia accompanying individual decisions, is possibly the most insidious divergence from the traditional assumptions underpinning choice models, for it appears directly in the response context.

Over 40 years ago, Blase (1979) was probably the first to provide empirical evidence about the practical significance of habit.

But the interest on this issue has not abated as most commuter trips tend to be repeated over time, acquiring a potentially important *inertia* component (Pendyala *et al.* 2001; Cantillo *et al.* 2007; Gardner 2015).

Let us consider the S-shaped curve typical of binary choice.

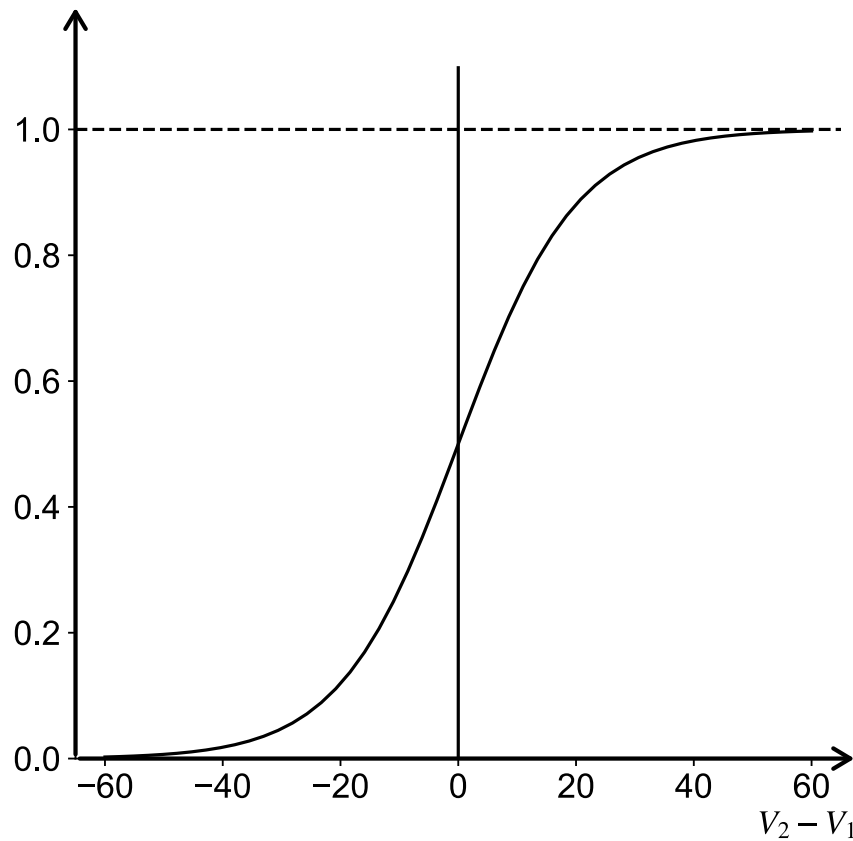




a) Logit response curve

For a given difference in utility ($V_2 - V_1$) there is a unique choice probability; if conditions change, either positively or negatively, the probability will correspond to that observed for the utility difference from the base year; that is, response is determined from the cross-sectional dispersion.





a) Logit response curve

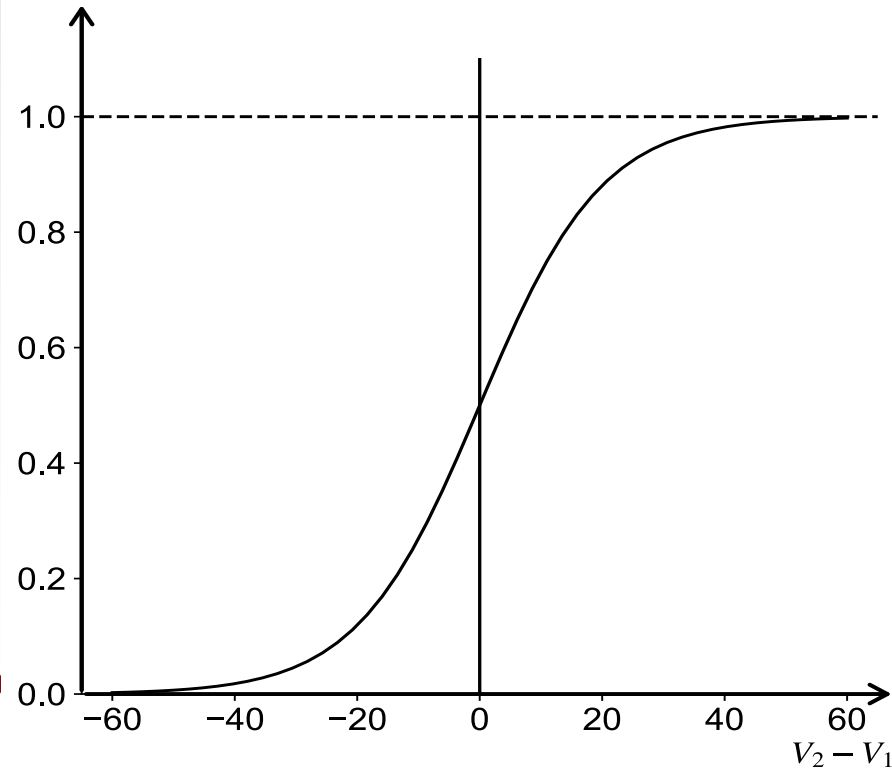
An implication of this assumption is that response to a particular policy will be exactly reversed if the policy is removed; that is, the stimulus–response relation is symmetric with respect to the sign and size of the stimulus.



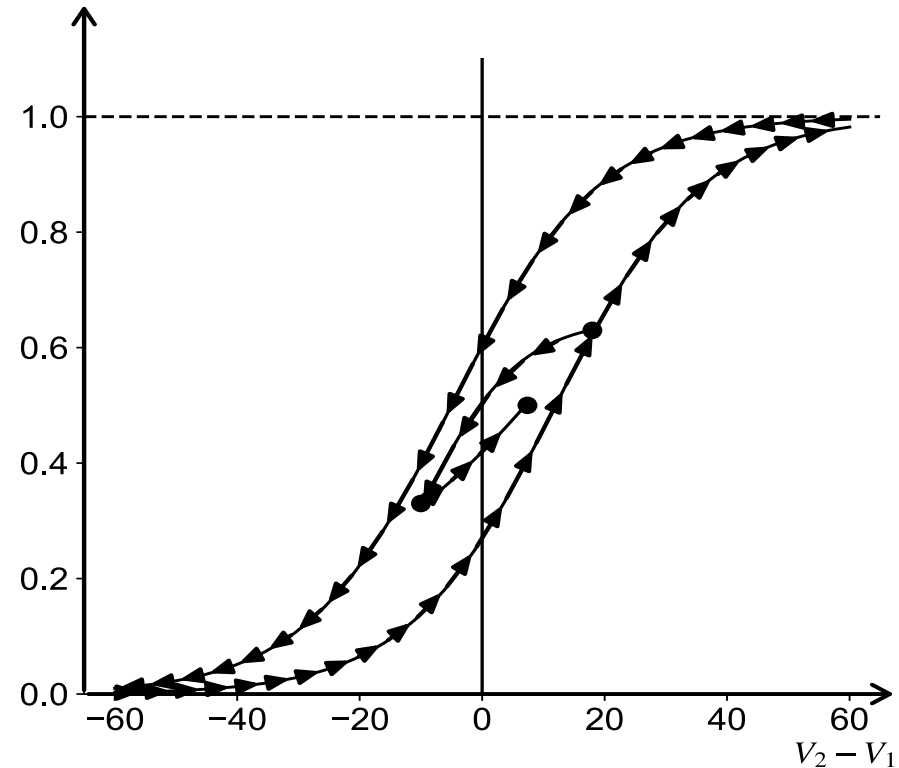
Background

However, real life is not like that. If habit exists it will affect individuals who are currently associated with a given alternative and experience a stimulus to the relative advantage of another one.

This introduces a basic asymmetry into response behaviour giving rise to the phenomenon of hysteresis (Goodwin 1977), as pictured in Figure 1b.



a) Logit response curve



b) Hysteresis curve for habit effect

Background

Formally, the state of the system P may be expressed as a path integral in the space of utility components \mathbf{V} ; its value is path independent when habit is absent but path dependent when it is present (Williams & Ortúzar 1982). These ideas were taken into an operational model by Cantillo *et al.* (2007), which was a precursor of a habit-shock panel data model proposed by Yáñez *et al.* (2009).

The *Santiago Panel* considered a changing choice environment before and after the introduction of *Transantiago*. This was a real *shock* to the system and was treated as another temporal effect beyond habit. The model incorporated the effects of three forces involved in the choice process:

- (i) the relative values of the modal attributes of the competing modes
- (ii) the habit (or inertia) effect, and
- (iii) the shock resulting from this abrupt policy intervention.

$$\tilde{U}_{jqw} = U_{jqw} - I_{jr}^w + S_{jq}^w$$



Background

If I denotes inertia and S shock, in principle there are several ways to express them. Yáñez *et al.* (2009) proposed the following expressions:

$$I_{jr}^w = (\theta_{Ij}^w + \delta_{Iq} \cdot \sigma_{Ij}^w + \theta_{I_SE} \cdot SE_I) \cdot (V_{rq(w-1)} - V_{jq(w-1)})$$

$$S_{jq}^w = (\theta_{Sj}^w + \delta_{Sq} \cdot \sigma_{Sj}^w + \theta_{S_SE} \cdot SE_S) \cdot (V_{jqw} - V_{jq(w-1)})$$

where θ^w are the population means and σ^w the standard deviations of the inertia and shock parameters for alternative j on wave w . SE are socio-economic variables allowing for systematic variations of I and S , and the parameters δ allow to introduce panel correlation.

Note that if $I > 0$ inertia exists, whilst if I is negative, the individual has a high disposition to change. Further, and as usual, attributes and SE characteristics have parameters that could be either fixed or random; finally, the random error term can be formulated as $\zeta_{jqw} = \nu_q + \varepsilon_{jqw}$; where ν_q is an individual specific random effect and ε_{jqw} is the typical random error distributed IID EV1.



Habit as a Latent Variable

First case: Bicycle choice

Among factors explaining growth in bicycle use, subjective variables, such as attitudes and perceptions, come up strongly (Bahamonde-Birke *et al.* 2017), e.g., people with a pro-environmental attitude find cycling more attractive. Notwithstanding, a strong barrier for choosing cycling is the risk perception (safety and security) this mode entails. Other important variables are trip distance, availability of cycle lanes, safe parking, and even showers and lockers at destination (Gutierrez *et al.* 2020).

But studies in psychology and human behaviour highlight that neither soft or hard measures to encourage changes are really effective if they are not accompanied by triggers that encourage change in individual habits.

To measure habit strength, some studies have incorporated the *Self-Report Habit Index* developed by Verplanken & Orbell (2003). We adapted a subscale for parsimony (see Gardner 2015).

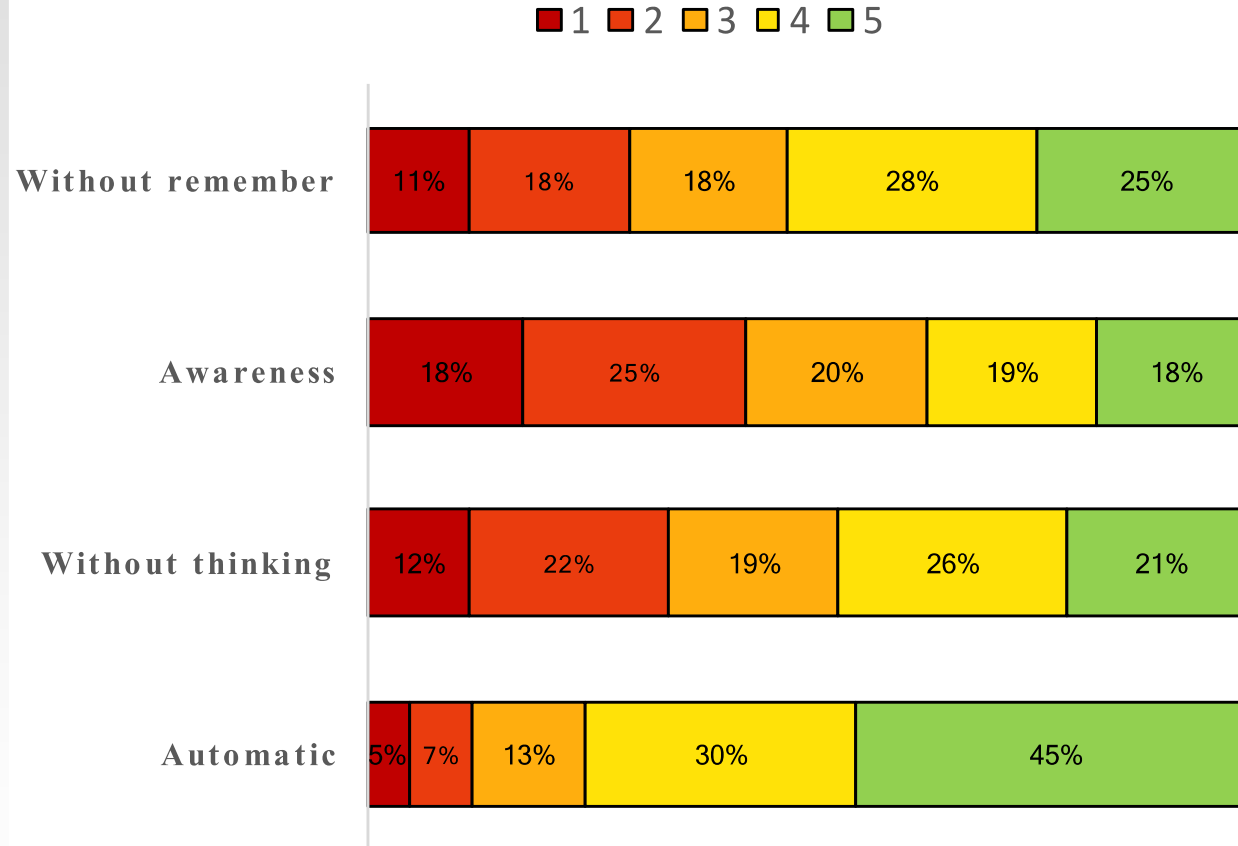


Habit as a Latent Variable

Statements	Indicators	Latent Variables
What would encourage you to make this trip by bicycle?		
Protected bicycle lanes along the entire route	Protected bike-lanes (P1)	Cycle facilities (0.78)
Bicycle parking areas near to my place of work/study	Near parking (P3)	
Guarded or enclosed bicycle parking areas	Guarded parking (P4)	
Availability of showers/lockers at my place of work/study	Showers and Lockers (P5)	
What stops or would stop you from making this trip by bicycle?		
I am concerned about the possibility of having an accident	Accident (B4)	Risk (0.74)
I am concerned about the possibility of being robbed	Robbery (B5)	
I am concerned about having a mechanical problem and not knowing what to do	Broken bike (B6)	
Using my "Current Transport Mode" for my daily trip to work or study, is something that:		
I do automatically	Automatic (A1)	Habit (0.86)
I do without thinking	Without think (A2)	
I start doing before I realize I am doing it	Awareness (A3)	
I do without having to consciously remember	Without remember (A4)	

Habit as a Latent Variable

Summary of habit indicators



Habit as a Latent Variable

Second case: Motorcycle use

Motorcycle use has grown steadily especially in Asia (in India, Indonesia, the Philippines Thailand, Taiwan and Vietnam, there are more motorcycles registered than cars). The low acquisition and operational costs associated with the motorcycle, and its ease for (dangerously) driving through dense traffic at rush hours, make it an interesting alternative mode in developing cities of Africa and Latin America too.

But few efforts have been made to explore the underlying motivations for owning and using a motorcycle and to define public policies for controlling or managing its growth, given its high environmental and safety impacts.

Additionally, experts debate whether the increase in its use is connected with a decrease in public transport patronage, as this would be another reason to consider that the mode may be a setback for sustainable urban planning.

We refer here to a study with these aims done in Bogotá (Mesa *et al.* 2023).



Habit as a Latent Variable

Preference for using motorcycle

= $\begin{cases} \text{Low,} & \text{if motorcycle is not used in all commuting trips (31.5\%)} \\ \text{Medium,} & \text{if motorcycle is used for all commuting trips (35.1\%)} \\ \text{High,} & \text{if motorcycle is also used for other types of trips (33.3\%)} \end{cases}$

(2)

Latent variables	Attitudinal questions
Public transport perception	Public transport is for me Public transport is fast Public transport is secure
Pro-motorcycle personality	Having a motorcycle matches my lifestyle I like using a motorcycle Buying a motorcycle was important for me Travelling on a motorcycle makes me feel free Travelling on a motorcycle makes me feel pleasure
Habit	For my main trip, I use a motorcycle without a doubt Not using the motorcycle for my main trip is difficult



Habit as a Latent Variable

Variable	Medium preference		High preference	
	Estimate	Rob. t-test	Estimate	Rob. t-test
ASC	0.36	2.39	-1.34	-2.34
LV: Habit	-	-	0.289	2.12
LV: Public transport perception	-0.324	-1.82	-0.544	-1.79
LV: Pro-motorcycle personality	0.485	2.66	0.325	1.76
Accident	-	-	-0.688	-2.21
Alternative mode: Pub. transport	-	-	2.422	1.95
Alternative mode: Apps/taxi	1.318	1.68	-	-
Educational level: Middle level	-0.863	-1.99	-	-
Educational level: High level	-1.478	-2.36	-	-
Friend with a motorcycle			0.634	1.68
Income: Middle level	0.71	1.85	0.604	1.92
Male	-	-	0.648	2.21
Shared motorcycle	-0.882	-2.49		
Worker	1.231	1.74	-	-
Population density (500 m)	0.021	1.82	-	-
Lives in the periphery	0.738	2.03	-	-



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- Blase, J.H. (1979) Hysteresis and catastrophe theory: a demonstration of habit and threshold effects in travel behaviour. *7th PTRC Summer Annual Meeting*, University of Warwick, England.
- Cantillo, V., Ortúzar, J. de D. & Williams, H.C.W.L. (2007) Modelling discrete choices in the presence of inertia and serial correlation. *Transportation Science* **41**, 195-205.
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- Verplanken, B. & Orbell, S. (2003) Reflections on past behaviour: a self-report index of habit strength. *Journal of Applied Social Psychology* **33**, 1313-1330.
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Parameters	SOL Model	HOL Model
	Value (t-test)	Value (t-test)
Age	-0.027 (-3.77)	-0.027 (-2.58)
No. of cars	-0.140 (-1.84)	----
Female	-0.335 (-2.43)	----
No. of bicycles	0.191 (3.45)	0.103 (1.15)
Household size	-0.104 (-1.63)	-0.132 (-1.52)
Car users	-0.676 (-4.25)	-0.948 (-3.65)
Trip length	-0.078 (-5.66)	-0.086 (-2.33)
Zone of residence mean income	-0.095 (-3.33)	-0.132 (-3.00)
Origin cycleway length	0.180 (1.50)	----
Destination land use entropy	-1.034 (-2.13)	-1.295 (-1.80)
LV: Spontaneity	----	0.093 (3.00)
Frequency)	----	-0.157 (-4.51)
Kids at home)	----	-0.158 (-1.84)
Number of cars	----	-0.045 (-1.26)
Origin metro stations	----	-0.100 (-1.54)
LV: Risk	----	-0.876 (-1.92)
Female	----	0.578 (7.18)
No. of bicycles	----	-0.085 (-3.02)
Age	----	0.009 (2.39)
Origin cycleway length	----	-0.129 (-2.11)
LV: Bicycle facilities	----	1.122 (1.38)
No. of cars	----	-0.111 (-3.06)
No. of bicycles	----	0.103 (3.59)
Low income	----	0.314 (3.26)

Note that two variables that appeared in the reference SOL model lost significance (*gender* and *meters of cycleways*) and did not appear directly in the utility function of HOL. However, as they are part of the structural equation for the *risk* variable, their impact is preserved in the model. Further, this provides an exciting insight for public policy, suggesting that women are less likely to ride a bicycle more for perceived security (not only in terms of risk but also in terms of feeling less able to resolve mechanical failures) than for other reasons, something that we could ameliorate with well-designed educational campaigns. Similarly, the role of the length of nearby cycleways increases its significance but is now included through the *risk* latent variable, indicating that the importance of providing a well-connected network of cycling infrastructure has to do primarily with the increase in perceived safety that it generates.



MIT Mobility Forum: Modelling Sustainable Options - the importance of habit and perceptions
Juan de Dios Ortúzar, 03/10/2023
Annotation by: Yunhan Zheng

Part I: Relevant Literature

Bahamonde-Birke, F.J., Kunert, U., Link, H. & Ortúzar, J. de D. (2017) About attitudes and perceptions – finding the proper way to consider latent variables in discrete choice models. *Transportation* 44, 475-493 .

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Part II: Summary

In this talk, Professor Ortuzar discussed the importance of habit and perceptions in modelling sustainable options and explained how habit can affect individual decisions and how it can be incorporated into choice models. Professor Ortuzar began by discussing the concept of habit and its significance in choice models. He argued that habit is possibly the most insidious divergence from traditional assumptions underpinning choice models, as it appears directly in the response context. The paper provides empirical evidence about the practical significance of habit, citing studies that show how most commuter trips tend to be repeated over time, acquiring a potentially important inertia component.

Professor Ortuzar then went on to discuss how habits play a role in the choice probability function. He argued that habits tend to introduce a basic asymmetry into people's response behavior. He then introduced a habit-shock panel data model, which incorporated the effects of three forces involved in the choice process: the relative values of the modal attributes of the competing modes, the habit (or inertia) effect, and the shock resulting from this abrupt policy intervention. In the end, Professor Ortuzar introduced two case studies to illustrate how habits might affect people's choices for cycling and motorcycle use.

Overall, the talk by Professor Ortuzar provides valuable insights into the importance of habit and perceptions in modeling sustainable options. It offers practical suggestions for incorporating these factors into our decision-making processes to promote sustainability.

Part III. Q&A between Jinhua Zhao and Juan de Dios Ortuzar

Zhao: The utility maximization framework presumed people made choices to maximize their utility. But the theory on habits implies that people are doing things without thinking about utility. So is the theory on habits something different from utility maximization?

Ortuzar: It may be true that people do things without thinking in a system that doesn't change at all. However, there is never such a thing that never changes at all. And if there is a shock, the shock will break the habit. This will bring about another optimization. This also ties to the idea that not all people choose in the same way. This is a really intricate field of study.

Zhao: How successful are engineers really working closely with psychologists, or are transportation engineers just reading some literature, borrowing some ideas without a deeper engagement with the psychologists?

Ortuzar: Well, I have been in the second type. I have admired psychologists for 30 years. Scholars like Thomas Hancock and Stephen Hess have really tried to incorporate the work of psychologists into their choice models. But it's very complicated, because psychologists don't want to predict things. They are not pragmatists like we are. They want to understand. We also want to understand, but we want to understand because we want to predict. Therefore, our models are much simpler in a sense, but they will give results which are very useful.

Zhao: As I mentioned that there are a lot of bad habits in transportation, both individually but also collectively. That is at odds with our climate change goal and public health goal. So my question is: how can we tackle these problems and trigger a different formation of habits?

Bhat: These are very open questions. We are certainly in an exciting moment. In our past research, we found that to move people towards transit use and bicycling, the best time to do that is when we are young. When we are young, we are more malleable. But people are less prone to change as they age. Also, maybe we can ping parents so that they can bring about some changes in their children's habits.

Zhao: My last question is about how to bring academic research into transportation planning practice. Do you have any insights into it?

Bhat: I have not done very many practical studies, really. I don't think I have seen any real incorporation of something like habits in practical models for urban planning so far.

Part IV: Audience Q&A

The audience had several questions and comments related to transportation sustainability and habit formation. Here's a brief summary of the main points:

- John Niles asked about the effectiveness of periodically implementing car-free days in cities as a means to influence long-term mode choice habits.
- Amir Brudner responded to Shoichi's comment about narrow roads leading to higher safety and more cyclists, agreeing with the idea.
- James Shaw raised the question of how to account for seasonal weather changes in transit planning and whether it's better to plan transportation options around days with the worst weather or nicer weather, which may lead to less sustainable outcomes.
- Jonathan Sutter asked whether the analysis considered decisions about whether to bike or ride a motorcycle as part of an overall journey that may involve other modes of transport.

- Ellie McLane asked how best to harness the start of a new school year or semester as an opportunity for habit resets and establishing new norms.
- Samuel Chin commented on how habit is influenced by the environment in which a person grows up.
- McKenzie Humann wondered how to measure response to sequential small changes over time periods for habit formation.
- Victor Alhassan suggested involving co-author Dr. Luis Willumsen in the discussion.
- Martin Schmidt asked whether age or other life changes had a greater impact on habit formation.
- Chandra Bhat responded to Martin's question by stating that age has a particular correlation with how much habit influences our choices, and the older we are, the more we stick to our habits.
- Erik Sabina mentioned the "Lenten fast" length of time as potentially effective for effecting lasting change.
- Several people, including Chandra Bhat, Peter Russo, and Lea Schwehn, discussed the impact of status on habit formation and whether environmental behavior could be seen as a status symbol.
- Takahiro Yabe asked if there was empirical or observational analysis showing the patterns of behavioral hysteresis discussed in the presentation.

Part V: Summary of Memos

Shoichi Ishida was interested in the relationship between transportation modes and people's habits, particularly in the context of sustainability, and suggested that the model could be improved by looking at outlier countries and including country-specific factors. Nineveh O'Connell wondered how quickly new habits form en masse when there is a significant interruption and how to measure the impact of small changes on habits. McKenzie Humann questioned the characteristics that make a habit more or less "friction-full" and discussed the importance of pricing for transit systems and people's awareness of their transportation habits. Yen-Chu Wu stated that understanding the role of intangible factors like habits is critical for promoting sustainable transportation systems. Identifying and addressing the underlying reasons for people's transportation choices can develop policies and interventions that encourage sustainable modes of travel. Yunhan Zheng is interested in exploring the impact of habits on travel behavior in the aftermath of the COVID shock that can help identify factors that drive people to adopt new transportation behaviors or stick to old ones. Samuel Chin stated that habits are shaped by the environment in which people grow up. Changing habits can only work if the public infrastructure already exists, and it's hard to attribute the transition or success due to the change in habit alone. Ao Qu emphasized that Professor Ortuzar discussed the concept of preference heterogeneity and proposed a methodology to incorporate it into discrete choice models. This approach can provide insights into policy and planning decisions in transportation.

Michael Leong reflects on how Ortuzar's research on habits in transportation behavior relates to his current research on understanding the causes behind travel pattern changes during COVID-19. He questions the relevance of habit in the post-COVID era, where flexibility and exploration are newly desirable values, and wonders how this translates to behavioral analysis perspectives. Jason Luo highlights the importance of pro-environmental attitudes, perceptions of risk, distance, availability of facilities, and climate in bicycle choice, and describes the self-report habit index as a tool for measuring the strength of habit. James Shaw finds habit to be a barrier to shifting modes for sustainability but suggests that "nudges" such as introducing/promoting alternatives can help change habits. He wonders about the extent to which governments should gently nudge individuals towards sustainable modes versus making existing habits less desirable and suggests hearing from a psychologist to further explain individuals' habits and their capacity to change.